Casting & Welding Engineering (IE 203)

Second Year,
Industrial Engineering Dept.,
Faculty of Engineering,
Fayoum University

Dr. Ahmed Salah Abou Taleb
Aims of the course

This course is designed to provide students with a thorough understanding of the Casting and Fabrication (Welding) processing to construct simple products.

Sand casting and special casting processes, Welding, and joining processes are be be introduced.
Course Outlines

Part One: Casting

- Casting technology.
- Sand Casting
- Patterns.
- Cores.
- Foundry equipments.
- Casting processes and techniques.
- Molding materials and their properties.
- Melting furnaces.
- Charge calculations.
- Design of gating and rises.
- Solidification of molten metals and alloys.
- Casting defects and inspection techniques: DT & NDT.
Course Outlines (Cont.)

Part Two: Welding

- Welding technology.
- Fusion welding.
- Resistance welding.
- Brazing, soldering and other welding techniques.
- Thermal and metallurgical changes during welding.
- Weld defects: causes and remedies.
- Assessment and weld quality.
- Inspection: DT & NDT.
Teaching and Learning Methods

- Power Point Lectures.
- Assignments.
- Quizzes.
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Introduction

Manufacturing Processes

- Casting
  - Sand casting
  - Shell mould
  - Die casting
  - Centrifugal
  - Plaster mould
  - Precision
  - Permanent
- Forming
  - Rolling
  - Drop forging
  - Press forging
  - Upset forging
  - Extrusion
  - Wire drawing
  - Sheet metal
- Fabrication
  - Gas welding
  - Electric arc W
  - Ele. Resistance
  - Thermal W
  - Cold welding
  - Brazing
  - soldering
- Metal Removal
  - Turning
  - Drilling
  - Milling
  - Shaping
  - Grinding
  - Sawing
  - broaching
Introduction
Introduction
Casting
Solidification Processes

Starting work material is either a **liquid** or is in a **highly plastic** condition, and a part is created through solidification of the material.

- Solidification processes can be classified according to engineering material processed:
  - Metals
  - Ceramics, specifically glasses
  - Polymers and polymer matrix composites (PMCs)
Solidification Processes

Figure: Classification of solidification processes
Casting Process

Material

Melting

Pouring into the mold

Cooling

Removing molding frame

Metal cast with remaining sand

Sand remains

Washing

Metal Cast

Finishing
Casting Process

Process in which *molten metal flows* by *gravity* or other *force* into a *mold* where it solidifies in the *shape of the mold cavity*

- The term *casting* also applies to the part made in the process
- Steps in casting seem simple:
  1. Melt the metal
  2. Pour it into a mold
  3. Let it freeze
Advantages of Casting

• Can create complex part geometries
• Can create both external and internal shapes
• Some casting processes are *net shape*; others are *near net shape*
• Can produce very large parts
• Some casting methods are suited to mass production
Disadvantages of Casting

– Limitations on mechanical properties
– Poor dimensional accuracy and surface finish for some processes; e.g., sand casting
– Safety hazards to workers due to hot molten metals
– Environmental problems
Parts Made by Casting

- **Big parts:** engine blocks and heads for automotive vehicles, wood burning stoves, machine frames, railway wheels, pipes, church bells, big statues, and pump housings

- **Small parts:** dental crowns, jewelry, small statues, and frying pans

- All varieties of metals can be cast, *ferrous* and *nonferrous*. 
Overview of Casting Technology

• Casting is usually performed in a foundry

*Foundry* = factory equipped for making molds, melting and handling molten metal, performing the casting process, and cleaning the finished casting

• Workers who perform casting are called *foundrymen*
Overview of Casting Technology

Basic Requirements of Casting Processes

- The mould material has a higher melting point than the molten metal
- The mould contains a cavity
- The form of the cavity is determined by the pattern
- The pattern is slightly larger than the finished casting
- The pattern can be removed from the cavity
The Mold in Casting

• Contains cavity whose geometry determines part shape
  – Actual size and shape of cavity must be slightly oversized to allow for shrinkage of metal during solidification and cooling
  – Molds are made of a variety of materials, including sand, plaster, ceramic, and metal
Figure: Two forms of mold:

(a) open mold, simply a container in the shape of the desired part; and
(b) closed mold, in which the mold geometry is more complex and requires a gating system (passageway) leading into the cavity
Two Categories of Casting Process

1. **Expendable mold processes** – uses an *expendable mold* which must be destroyed to remove casting
   - Mold materials: sand, plaster, and similar materials, plus binders

2. **Permanent mold processes** – uses a *permanent mold* which can be used many times to produce many castings
   - Made of metal (or, less commonly, a ceramic refractory material)
Advantages and Disadvantages

• More **intricate** geometries are possible with expendable mold processes
• Part shapes in permanent mold processes are **limited** by the need to open mold
• Permanent mold processes are more **economic** in high production operations